APPLICATION FOR UNITED STATES LETTERS PATENT

Split-Frame for Heavy Trucks

by

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FIELD OF THE INVENTION

The present invention relates to the field of frames for heavy trucks or tractors and more particularly to split-frame structures for heavy trucks designed to reduce the transmission of road vibrations from the trailer to the truck cab.

BACKGROUND

The trucking industry is one of the primary means of transporting goods and equipment in the United States. In 1994, the trucking industry hauled 5.5 billion tons of freight accounting for 55 percent of the total domestic freight volume. To handle this volume of freight, the trucking industry estimates that it will require 300,000 to 500,000 new truck drivers each year. To attract this workforce, and retain the present workforce, the trucking industry is constantly seeking new ways to improve the working conditions and living quality of heavy trucks for its drivers.

Rough roads, railroad crossing, and the like, cause vibrations that are felt by the occupants of the truck's cab. Road vibration is one of the greatest causes for driver fatigue experienced. Vibrations can be transmitted directly from the road surface to the occupants through the suspension of the truck. However, these same vibrations are also transmitted indirectly through the trailer linkages coupling the trailer to the truck.

Heavy truck drivers commonly operate in two person teams. Frequently, while one person is driving the truck, the other person will sleep in a sleeping compartment at the rear of the cab. It is therefore desirable, both for the on-duty driver, and the off-duty driver sleeping, to stabilize the movement of the truck cab and minimize the vibrations

and oscillations caused by rough surfaces. One primary method of achieving this goal is through minimizing the transmission of the trailer's vibrations and oscillations to the truck cab. Therefore, there is a current and continuing need for structures and mechanisms that will reduce the amount of road vibration felt by occupants of a truck.

In the current state of heavy truck technology, the truck is comprised of a cab attached to the front end of a single rigid frame. The heavy truck attaches and holds a trailer through a fifth wheel coupler mounted at the rear of the truck frame. The fifth wheel couples the truck frame to the kingpin of the trailer.

When travelling across a road, a truck and trailer will frequently drive over minor road imperfections such as concrete seams and potholes. A road imperfection that is symmetrically impacted by the trailer, such as a concrete seam, will cause the trailer to vibrate vertically, or to rock about a transverse axis. A road imperfection that is asymmetrically impacted by the trailer, such as a single pothole, will cause the trailer to have both a transverse and a longitudinal axis of motion. Due to the trailer's mechanical engagement with the truck, these mechanical vibrations and oscillations of the trailer are transmitted to the truck and the passenger cab. This transmission of vibrations and oscillations to the cab disturbs the smooth ride for the driver and passengers.

There have been truck designs that attempt to minimize the transmission of trailer vibrations and oscillations through pivotally mounting the fifth wheel with ball joints. The motion of the pivotally mounted fifth wheel is then dampened with hydraulic cylinders. In contrast, the present invention utilizes a split-frame system to minimize the transmission of trailer vibrations. This split-frame system reduces the transmission of

road vibrations by mounting the front and rear axles of the truck on two separate moveably interlocked frames.

Inventors have developed many other devices that reduce the transmission of road vibrations to the trailer and the truck cab to enhance the ride quality for both the drivers and the freight. Halvorsen et al., U.S. Pat. No. 5,330,222, discloses a frame isolation system which enhances the ride quality of a terminal tractor. This patent discloses a single tractor frame assembly that includes an axle saddle provided with leading and trailing anti-torque links which permit the axle to move through a limited displacement to compensate for rough and uneven road surfaces. In contrast to the present invention, this patent does not teach the mounting of the front and rear axles on separate frames to reduce the transmission of trailer vibrations to the passenger cab.

A flexible joint assembly used in tandem wheel and axle suspensions for suspending a vehicle chassis is disclosed in Jable et al., U.S. Pat. No. 5,078,420. This patent discloses the pivotal mounting of equalizer leaf springs to a chassis side rail. The dual wheels of this device are separately mounted and separately flexible.

A frame/subframe assembly for mounting an engine and rear wheels to a race car chassis is disclosed in Huszr, U.S. Pat. No. 3,806,149. This patent discloses that the racecar engine and rear wheels are mounted to a subframe made of two side rails. The subframe is spring-mounted in the front and pivotally mounted at the rear to the main frame. The subframe is pivotally mounted with bolts to the mainframe at a point below and forward of the rear axle. The stated object of this subframe system is to provide a structure that allows for engine and chassis torque. A further object of this suspension is to provide a wheeled subframe for the engine to facilitate the repair and maintenance on

the engine. This patent does not teach the use of a split-frame system, as in the present invention, to reduce the transmission of vibrations between a trailer and a heavy truck cab.

The present state of the art for motor vehicle frame systems fails to teach a heavy truck that includes a split-frame system mounting the front and rear axles on separate frames that reduces the transmission of transverse vibrations from the trailer to the truck cab. In addition, the present state of the art fails to disclose a split-frame system that also reduces the transmission of rotational vibrations from the trailer to the truck cab.

SUMMARY OF THE INVENTION

In accordance with the invention claimed, a novel heavy truck frame system is disclosed that reduces the transmission of the vibrations and oscillations of the trailer along its longitudinal and transverse axes to the truck cab. This heavy truck frame system is comprised of three rigid frames, referred to as the front frame, the rear frame, and the interconnecting frame. The front frame supports the truck cab, front axle, engine, and transmission. The rear frame supports the two rear drive axles and fifth wheel. The fifth wheel couples to the kingpin of the trailer. The interconnecting frame interlocks the front frame to the rear frame in such a manner to permit the rear frame to move relative to the front frame. The interconnecting frame is secured to the front frame in such a manner as to allow the interconnecting frame to pivot or rotate about its longitudinal axis relative to the front frame. A preferred means of securing the interconnecting frame to the front frame that permits this freedom of movement is a bearing guided pivot. The interconnecting frame is rigidly secured to the front frame with respect to all other degrees of freedom. The interconnecting frame is connected with the rear frame through

a pair of self-centering bearings. This structure enables the rear frame to pivot or rotate about its transverse axis relative to the front frame. Therefore, the interconnecting frame enables the rear frame to pivot or rotate about is longitudinal axis and rotate about its transverse axis relative to the front frame.

When the rear wheels of a trailer impact a minor road imperfection such as a road seam or pot hole, the trailer will vibrate or oscillate about a transverse axis. Due to the fact that rear frame, having the fifth wheel rigidly mounted thereon, is free to rotate or pivot about its transverse axis relative to the front frame, the transmission of these transverse vibrations or oscillations to the trailer is reduced. When a trailer impacts a minor road obstruction on only one side, the trailer will vibrate or oscillate along its longitudinal axis. Due to the fact that the interconnecting frame enables the rear frame that is coupled to the trailer to rotate about its longitudinal axis relative to the front frame, these longitudinal vibrations are not transferred to the front frame.

In order to control the vibrations and oscillations of the rear frame relative to the front frame, a vibrational dampening system is included. Two hydraulic cylinders are connected to the front and rear frames to dampen the relative vibrations and oscillations between these two frames. These hydraulic cylinders do introduce a small amount of virbational coupling between the front and rear frames.

Enabling the rear frame to pivot and rotate about its transverse and longitudinal axes independent of the front frame reduces the transmission of trailer's vibrations and oscillations to the truck cab. This design therefore provides a smoother ride for those persons riding in the cab.

An alternative embodiment of the present invention would include a direct connection between the front frame and the rear frame without the need for an inner-connecting frame.

It is a primary object of the present invention to provide a heavy truck frame system that stabilizes the movement of the truck cab to provide a smooth ride for the driver and passengers.

It is a further object of the invention to provide a split-frame system that minimizes the transmission of the trailer's vertical vibrations to the truck cab.

A still further object of the invention is to provide a split-frame system that minimizes the transmission of the trailer's rotational vibrations to the truck cab.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize this invention are pointed out with particularity in the claims annexed to and forming a part of this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features that are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its structure and its operation together with the additional object and advantages thereof will best be understood from the following description of the preferred embodiment of the present invention when read in conjunction with the accompanying drawings wherein:

FIG. 1 is a perspective view of the split-frame system illustrating the front frame, rear frame, interconnecting frame, and hydraulic dampening system;

FIG. 2 is a side view of the split-frame system;

FIG. 3 is a perspective view of the interconnecting frame in engagement with the front and rear frames;

FIG. 4 is a perspective view of the left side of the split-frame system illustrating the hydraulic dampening system;

FIG. 5 is a top view of the split frame system;

FIG. 6 is a perspective view of the left mechanical joint between the interconnecting frame and the rear frame;

FIG. 7 is a perspective view of the rear frame;

FIG. 8 is a side view of the split-frame system mechanically engaged to a trailer; and

FIG. 9 is a perspective view of an alternative embodiment for the configuration of the split frame system whereby the front frame is connected directly to the rear frame.

Description of Preferred Embodiments

Referring more particularly to the drawings by characters of reference, FIG. 1 discloses a perspective view of the split-frame system **1**. The split-frame system **1** is useful for reducing the transmission of vibrations and oscillations from a trailer to a truck cab **11**. The split-frame system **1** is comprised of three interconnected frames, a front frame **100**, a rear frame **200**, and an interconnecting frame **300**. These three frames are preferably made of hard alloy steel. The front frame **100** supports a front axle **10**, a truck cab **11**, an engine **12**, and a transmission **13**. The front axle **10**, having a pair of tires **14** mounted thereon, is positioned on front frame **100** such that the weight of front frame **100** and the components mounted thereon is evenly balanced over the front axle **10**.

The rear frame **200** supports a pair of rear axles **20** and a fifth wheel **40**. Each rear axle **20** has four tires **14** mounted thereon. Trailers are coupled to the rear frame **200**, typically through a coupler such as the fifth wheel **40**. The fifth wheel **40** couples to a kingpin of the trailer. In this embodiment, fifth wheel **40** is rigidly mounted to the rear frame **200**. Front axle **10** and rear axles **20** are supported by leaf springs **30** that are mounted on leaf spring joints **31**.

The interconnecting frame **300** interlocks the front frame **100** to the rear frame **200** in such a manner that permits the rear frame **200** to rotate about a transverse axis relative to the interconnecting frame **300**. In addition, the interconnecting frame **300** interlocks the front frame **100** to the rear frame **200** in such a manner that permits the rear frame **200** to rotate or pivot about its longitudinal axis relative to the front frame **100**. In this embodiment, the interconnecting frame **300** is positioned in the interior of the rear frame **200**. In an alternative embodiment, disclosed in FIG. 9, the rear frame **200** is mounted on the interior of the interconnecting frame **300**.

In order to restrict the degree to which the rear frame **200** can pivot or rotate relative to the front frame **100**, a pair of bumpers **60**, a left bumper **60A** and a right bumper **60B**, are provided. Each bumper **60** is made of a solid piece of rubber that is secured to the front frame **100** above the interconnecting frame by a metal bracket **61**. The bumpers **60** restrict the degree to which the interconnecting frame **300** may rotate about its longitudinal axis relative to the front frame **100** thereby restricting the degree to which the rear frame **200** may rotate relative to the front frame **100**. While two bumpers **60** are used to restrict the degree of rotation of the interconnecting frame **300** relative to the front frame **100** in this embodiment, a total of four bumpers **60** are used in an

alternative embodiment. A more detailed description of the interconnecting frame **300**, how it is mounted to the front frame **100** and the rear frame **200**, and how its motion is restricted by bumpers **60** is provided in FIGS. 3 and 4.

A hydraulic system **50** is provided to dampen the vibrations and oscillations within the split-frame system **1**. The hydraulic system **50** is comprised of two hydraulic cylinders **51** mounted to the split-frame system **1** through the use of ball joints **52** and **53**. The two hydraulic cylinders **51** are mounted on the left and right sides of the spit-frame system **1**. Each hydraulic cylinder **51** is mounted at the top to a rear ball joint **53**. Both rear ball joints **53** are secured to the rear frame **200**. The base of each hydraulic cylinder **51** is mounted to a front ball joint **52**. Both front ball joints **52** are secured to front frame **100**. Hydraulic system **50** dampens the rotational vibrations and oscillations of the rear frame **200** along its longitudinal axis relative to front frame **100**. In addition, hydraulic system **50** dampens the rotational vibrations and oscillations of the rear frame **200** about a transverse axis along the rear axles **20**. The use of ball joints **52** and **53** to mount hydraulic cylinders **51** enables the hydraulic cylinders **51** to adjust position to account for the relative movement of the rear frame **200** with respect to the front frame **100**. It is obvious to one skilled in the art that alternative systems and configurations are capable of performing the identical function of the system **50** used in this preferred embodiment. While the hydraulic system **50** introduces a small amount of vibrational coupling between the front and rear frames, **100** and **200**, respectively, its use introduces an amount of control in the movement between the two frames.

FIG. 2 discloses a side view of the split frame system **1**. When the split-frame system **1** is on a flat surface as shown in FIG. 2, both the front frame **100** and the rear

frame **200** are horizontal relative to the ground if a trailer is coupled to the fifth wheel **40**. In the event a trailer is not coupled to the fifth wheel **40**, the rear frame **200** will not remain horizontal relative to the ground. In this embodiment, the weight of the rear frame **200** and the components mounted thereon is not evenly balanced over the rear axles **20** as the weight of the front frame **100** is evenly balanced over the front axle **10**. The center of gravity of the rear frame **200** lies between the end of the rear frame **200** adjacent to the front frame **100** and the pair of rear axles **20**. When a trailer is not coupled to the fifth wheel **40**, the end of the rear frame **200** adjacent to the front frame **100** will pivot down toward the ground. It is desirable to maintain the rear frame **200** in a horizontal position when a trailer is not coupled to the fifth wheel **40** in order to safely operate the truck **2**. Alternatively, the hydraulic system **50** can be used to rigidly lock the rear frame **200** to the front frame **100** by altering the hydraulic pressure within the hydraulic cylinder **51**. The rear frame **200** can only pivot with respect to the front frame **100** when the rear frame **200** can compress and extend the hydraulic cylinder **51** with respect to the front frame **100**. When sufficient hydraulic pressure is created in the hydraulic cylinders **51** such that the rear frame **200** cannot compress or extend the hydraulic cylinder **51** with respect to the front frame **100**, the rear frame **200** is rigidly locked down to the front frame **100**.

FIG. 3 illustrates interconnecting frame **300** mechanically engaged with the front frame **100** and rear frame **200**. Interconnecting frame **300** is formed in the general shape of a wishbone with two arms **301** attached to two arm braces **302** that are attached to a coupling shaft **303**, and two pivot bearings **304**. The components of the interconnecting frame **300** are preferably made of a hard steel alloy. The preferred method of attaching

arms **301**, arm braces **302**, and coupling shaft **303** together is welding. Coupling shaft **303** is pivotally attached by two bearing guided pivots **305** to the front frame **100**. Coupling shaft **303** defines a longitudinal axis about which interconnecting frame **300** rotates relative to the front frame **100**. Arms **301** are rotationally mounted to the rear frame **200** through bearing guided pivots **304**. A pivot **304** is secured to each of the two arms **301**. Each pivot **304** has a pivot shaft **306** secured to the interconnecting frame **300** that is received by a pivot aperture with a bearing race located in the rear frame **200**. Pivot shaft **306** defines a transverse axis about which the rear frame **200** rotates relative to the interconnecting frame **300**. In an alternative embodiment, ball joints are used in place of these pivots **304**. The pivot shaft **306** is secured to rear frame **200** by caps **307**. The interconnecting frame **300** attaches front frame **100** to rear frame **200** while permitting rear frame **200** to rotate longitudinally and transversely relative to the front frame **100**.

The split-frame system **1** is provided with a hydraulic system **50** to dampen the vibrations and oscillations of the rear frame **200** relative to the front frame **100**. FIG. 4 illustrates a perspective view of the hydraulic cylinder **51** mounted on the left side of the split-frame system **1**. The hydraulic cylinder **51** is mounted at the top to a rear ball joint **53**. The rear ball joint **53** is rigidly secured to the rear frame **200**. The base of hydraulic cylinder **51** is mounted to front ball joint **52**. The front ball joint **52** is rigidly secured to front frame **100**. The use of ball joints permits the hydraulic cylinder **51** to alter position in relation to the relative motion between the front frame **100** and the rear frame **200**.

Also visible in FIG. 4 is one of the two bumpers **60**. The bumper **60** is rigidly mounted to the front frame **100** by bracket **61**. When the interconnecting frame **300**

rotates a sufficient amount in a clockwise direction about shaft **303**, the upper left end of arm brace **302** will impact against bumper **60**. In the alternative embodiment where four bumpers **60** are used, the bottom right end of arm brace **302** would impact against the bumper **60** mounted to the right side of the split-frame system **1** to front frame **100** below the interconnecting frame **300** as the upper left end of arm brace **302** impacts against the bumper **60** shown in FIG. 4. While these bumpers **60** do partially couple the front frame **100** to the rear frame **200**, the interconnecting frame **300** has sufficient freedom to rotate relative to the front frame **100** to account for the trailer vibrations and oscillations caused by most minor road imperfections. Therefore, the vibrations and oscillations of the trailer caused by minor road imperfections are not transferred to the truck cab **11**.

A top view of the split-frame system **1** is disclosed in FIG. 5. In this embodiment, the interconnecting frame **300** is configured to fit within the interior of rear frame **200**. Interconnecting frame arms **301** pivotally mount to the rear frame **200** on the interior of rear frame **200**. In an alternative embodiment, the interconnecting frame **300** is configured to attach to the rear frame **200** on the exterior of rear frame **200**. In this alternative embodiment, arms **301** are positioned on the exterior of rear frame **200**. In contrast to the pivot shaft **306** used to secure the interconnecting frame **300** to the rear frame **200** in the preferred embodiment, the alternative embodiment employs ball joints to pivotally secure arms **301** to the exterior of rear frame **200**.

The rear frame **200** is free to pivot only about a transverse axis relative to the interconnecting frame. The rear frame **200** is rigidly secured to the interconnecting frame **300** with respect to all other degrees of freedom. When a trailer experiences vibrations and oscillations about its longitudinal axis due to minor road imperfections, the trailer

will transmit these vibrations to the rear frame **200** due to its coupling with the fifth wheel **40**. The rear frame **200**, secured to the frame arms **301**, will vibrate and oscillate with the trailer about the coupling shaft **303**. Since the coupling shaft **303** is pivotally mounted to the front frame **100** by the two bearing guided pivots **305**, the longitudinal vibrations experienced by the rear frame **200** are not transmitted to the front frame **100**. The hydraulic cylinders **51** dampen this longitudinal vibrational motion of the rear frame **200** about its longitudinal axis relative to the front frame **100**. The two bumpers **60** limit the degree to which the interconnecting frame **300** can pivot or rotate relative to the front frame **100**. The bumpers **60** permit the interconnecting frame **300** to freely pivot for the small angular vibrations and oscillations caused by most minor road imperfections. However, the interconnecting frame **300** will impact bumpers **60** and transmit vibrations to the front frame **100** when large road obstructions cause the rear frame **200** to experience large rotational vibrations.

Similarly, when a pair of rear axles of the trailer encounters minor a road imperfection, the front end of the trailer will rotationally oscillate about a transverse axis. The trailer, coupled to the fifth wheel **40**, will cause the rear frame **200** to also rotationally oscillate about a transverse axis. Due to the fact that the rear frame **200** is free to transversely pivot about pivot shaft **306**, these transverse rotational vibrations are not transmitted from the rear frame **200** to the front frame **100**. Hydraulic cylinders **51**, secured to the front and rear frames **100** and **200** as previously described, dampen this rotational transverse vibration between the rear frame **200** and the front frame **100**.

A perspective view of one of the two identical pivotal joints between the interconnecting frame **300** and the rear frame **200** is shown in FIG. 6. A bearing guided

pivot **304** is bolted to arm **301**. A person skilled in the art may secure the pivot **304** to arm **301** by other conventional means such as welding. Pivot shaft **306** is rotationally coupled to the bearing guided pivot **304**. The pivot shaft **306**, as previously noted, is secured to rear frame **200**.

FIG. 7 discloses a perspective view of the rear frame **200**. This figure discloses the preferred embodiment of the invention where the interconnecting frame **300** is positioned within the interior of rear frame **200**. The arms **301** of interconnecting frame **300** having bearing guided pivots **304** mounted thereon are visible within the interior of rear frame **200** below the fifth wheel **40**. As described earlier, the fifth wheel **40** is rigidly secured to the rear frame **200**. The pivot shaft **306** that rotationally mounts the interconnecting frame **300** to the rear frame **200** is fixed to the rear frame **200** in this embodiment through the use of threaded nuts **307**. Other conventional means such as welding may be used to secure the pivot shaft **306** to the rear frame **200**.

A side view of the split-frame system **1** illustrating a trailer **80** coupled to the fifth wheel **40** is disclosed in FIG. 8. When the rear wheels of the trailer **80** impact a minor road obstruction, the rear portion of the trailer will vertically oscillate causing the front portion of the trailer **80** to rotationally oscillate about the rear axle **20** as shown by the arrows in this figure. In addition, the trailer **80** will cause the rear frame **200** to rotationally oscillate in a similar manner due to its coupling with the fifth wheel **40**. The pivotal mounting between the rear frame **200** and the interconnecting frame **300** prevents the transmission of the rotational oscillations from the rear frame **200** to the front frame 100. These oscillations experienced by the rear frame **200** are dampened by the hydraulic cylinder **51**.

An alternative embodiment for the structure of the rear frame **200** and the front frame **100** is disclosed in FIG. 9. The front frame **100** directly to the rear frame **200** in such a manner that permits the rear frame **200** to rotate about a transverse axis relative to the front frame **100**. In addition, the front frame **100** interlocks to the rear frame **200** in such a manner that permits the rear frame **200** to rotate or pivot about its longitudinal axis relative to the front frame **100**. In this embodiment, the front frame **100** is positioned on the exterior of the rear frame **200**. Ball joints **308** are used to pivotally mount the front frame **100** to the rear frame **200**.

While these descriptions directly describe the above embodiments, it is understood that those skilled in the art may conceive modifications and/or variations to the specific embodiments shown and described herein. Any such modifications or variations that fall within the purview of this description are intended to be included therein as well. It is understood that the description herein is intended to be illustrative only and is not intended to be limitative. Rather, the scope of the invention described herein is limited only by the claims appended hereto.